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(54) **Title:** NANOPORE SENSOR SYSTEM

(57) **Abstract:** The invention relates to a nanopore sensor system including methods of fabrication and uses disclosed herein. In some embodiments, the invention relates to a substrate comprising a lipid membrane, preferably a phospholipid bilayer film, having a nanopore and a gel surrounding said lipid membrane. In additional embodiments, the invention relates to compositions and methods of using and making a substrate that has a lipid membrane having a single channel protein surrounded with a gel. In further embodiments, the invention relates to a method of detecting an analyte by mixing a nanopore sensor with a solution suspected of containing an analyte, measuring electrical properties, and correlating changes of electrical properties to the existence of an analyte.

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US07/10170

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC: **B01D 69/00**( 2006.01)  
A61K 38/00( 2006.01)

USPC: 210/500.22,493.5;424/278.1,1.21

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
U.S. : 210/500.22,493.5;424/278.1,1.21

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
Please See Continuation Sheet

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                     | Relevant to claim No. |
|------------|--|-----------------------|
| X          | US 20060063171 A1 (AKESON M. ) 23 March 2006, Figures 1-6, paragraphs [0043] and [0096] and Example 2. | 1                     |
| X          | US 6952651 B2 (SU X.) 4 October 2005, column 10.   | 1                     |
| Y          | US 20030232346 A1 (Su, X.) 18 December 2003, patent claims 26-30 and paragraph [0056].                 | 1                     |

Further documents are listed in the continuation of Box C.

See patent family annex.

| * Special categories of cited documents:  |  |
|---|--|
| "A" document defining the general state of the art which is not considered to be of particular relevance  | "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  |
| "E" earlier application or patent published on or after the international filing date   | "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone   |
| "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "O" document referring to an oral disclosure, use, exhibition or other means  | "&" document member of the same patent family  |
| "P" document published prior to the international filing date but later than the priority date claimed  |  |

Date of the actual completion of the international search

28 August 2008 (28.08.2008)

Date of mailing of the international search report

**26 SEP 2008**

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US07/10170

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:  
Please See Continuation Sheet

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of any additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

- Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
  - The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
  - No protest accompanied the payment of additional search fees.

**BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING**

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim 1, drawn to a device comprising a lipid membrane that comprises a nanopore and a gel.

Group II, claims 2-10, drawn to a substrate comprising three layers wherein middle layer comprises an inner orifice containing a lipid membrane, and two outer layers comprise outer orifices configured to surround said membrane with said gel.

Group III, claims 11-19, drawn to a method of creating a gel covered lipid membrane comprising substrate comprising the steps of contacting the lipid with the solution having a surface and comprising a component for making said gel; contacting first orifice with said lipid to allow formation of a lipid membrane inside said first orifice; and modifying said solution for making a gel.

Group IV, claim 20, drawn to a method of detecting an analyte comprising contacting the device with a solution containing an analyte, measuring and analyzing electrical properties and change thereof which correlates with the presence of the analyte.

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons. Akesson et al. (US 20060063171 A1) teach a nanopore device comprising a single nanopore, i.e., nanopore aperture (see Figures 1-6) in a lipid membrane (see paragraph [0043], and Example 2, [0096]); and the device further comprises a molecular motor immobilized inline with the aperture on a gel matrix (see [0009]). Thus, the reference teaches the instant device of claim 1 (Group I) which is used in the method of Groups II and IV. The substrate of Group II is not required for the method of Group IV, nor is necessarily required for the method of Group III because the structural feature of the substrate of Group III may differ from that of the substrate used in the Group II method. Therefore, Groups I-IV are not so linked by the same or corresponding special technical features within meaning of PCT Rule 13.2, i.e., the current application lacks a single general inventive concept.

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US07/10170

Continuation of B. FIELDS SEARCHED Item 3:

STN, US Pre-Grant publication Full-Text database, US Patent Full-Text database, EPO Abstracts database, JPO Abstracts database, issued patents AA, pending patents AA and Genbank (for sequence search).

Search terms: nanopore, lipid bilayer or biomembrane, matrix/gel.